CARPOOLING: an overview with annotated bibliography

by

ROGER PLUM and JERRY EDWARDS

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Because of increasing social and environmental awareness and skyrocketing land and construction costs, the era of large-scale freeway design and construction is past. Realizing that the future supply of these high-volume, limited-access roadways is essentially fixed at present levels, transportation planners, decision-makers, and engineers must now cope with the problems of congested roadways, increasing travel demands, pollution of the air in and around our cities, and the relatively rapid depletion of our energy resources. A logical solution to these problems is to substantially increase vehicle occupancy, thereby decreasing the number of vehicles on the road and at least partially solving the problems of more travel, increased pollution, and loss of energy resources.

It has often been proposed that improving transit service is the best way to achieve greater vehicle occupancies. This paper considers this case, then proposes the use of carpooling to achieve the goal of decreased congestion. Finally, the main body of this paper presents a discussion of incentives and disincentives related to ridesharing.

CARPOOLING VS. MASS TRANSIT

Proponents of public bus and rail transit contend that mass transit is the most effective way to decrease the number of vehicles on the road. Currently, bus and rail transit are primarily oriented to the central business district (CBD) with high ridership in most cities during the morning and afternoon peak periods--when riders are traveling to and from work--and low ridership during off-peak hours--when riders are primarily the young, the elderly, the poor, the handicapped, or others either unable or unwilling to drive automobiles.

Two problems with conventional transit arise at this point. First, a large number of businesses are locating or relocating in scattered areas removed from the CBD, generally in suburbs of the central city. These businesses are relatively inaccessible by conventional CBD-oriented transit. As a result, their employees drive to work, rather than taking a transit trip, which in most such cases would be longer (both in time and distance) and might require one or more transfers. Second, labor unions demand that transit

operators be employed full-time. Since bus transit is a relatively labor intensive industry, high operating costs are incurred by bus lines offering widespread service. Whereas the costs of running buses during peak hours may be covered by fares received during those hours, fares received during off-peak hours only rarely pay their own way. As a result, nearly all transit agencies operating buses in the United States are heavily subsidized.

Rail transit has been practical in only a few instances, because the costs of implementing and maintaining an effective rail transit system have recently become prohibitive. In some cases, rail transit, like bus transit, is heavily subsidized by government.

Attempts to increase transit ridership during off-peak hours by offering service to major non-CBD activity centers--primarily suburban shopping centers--have met with only marginal success in a few cities. The general failure of these efforts may be attributed to the lack of concentration of both the locations of shoppers' homes and the times of day when shopping trips are made. Therefore, for transit to decrease the number of vehicles on the road the primary focus must be on peak period work trips. But transit is already operating at or near capacity during peak hours. To increase vehicle occupancy by persuading automobile drivers to switch to riding transit will require more transit vehicles. More transit vehicles will require more operators requiring full-time work, creating the need for increased rather than decreased subsidies.

Carpooling is an option which may increase vehicle occupancy without some of the problems related to improving transit service. Eighty percent of all vehicle-miles traveled in the United States are by automobile. Of these, 35 percent are by commuting automobiles. Of these commuting automobiles, 75 percent contain only one person, the driver (Muehlke 1975). This means that in the United States 21 percent (about one-fifth) of all vehicle-miles traveled are by single-occupant commuting vehicles. Because 80 percent of all non-work trip vehicle-miles are in vehicles containing two or more persons, it is evident that the primary focus of attention for increasing vehicle occupancy should be upon commuter work trips. Commuter work trips are well-defined for each individual. Origins and destinations remain constant for relatively long periods of time, occurring daily during the work week and at the same times each day. Carpooling appears to be well-suited to these trips.

Carpooling has several advantages. In reviewing consumer attitudes toward transportation services, Wachs (1976) mentioned several of them. First, he observed that travel time reliability is as important as, if not more important than, total travel time. In a study conducted on the Shirley Highway into Washington, D.C., 90 percent of the express bus riders surveyed cited travel time reliability as important in their decision to ride the bus, whereas only 29 percent cited the five-minute travel time savings as important. Logically, if carpools are allowed to use the same exclusive rights-of-way as express buses--as carpools of four or more persons have been allowed to do on the Shirley Highway--they will be as time reliable as express buses and will give the same travel time savings as well. In addition, carpoolers are not bound by a schedule as are express bus riders.

Second, Wachs perceived that time spent waiting, walking, transferring, and parking is weighted more heavily than in-vehicle time. Since most carpooling arrangements offer essentially door-to-door service, waiting and transferring times are nearly non-existent. Considering that carpool parking locations at work can be chosen close to, if not at, the work location, walking and parking times for carpoolers can be expected on average to be at least as low as walking and parking times associated with riding transit. In instances where passengers in the carpool do not work near the parking area, those passengers may be dropped at a convenient location near their places of work before the vehicle is parked. Thus, carpools show an advantage over transit in decreasing waiting and walking time and in the flexibility of the arrangement.

Third, Wachs found parking costs to be fairly important in the commuter's choice of transportation mode. The most common reason mentioned by automobile drivers who were former Shirley Highway express bus riders for switching back to the automobile was the high cost of riding the bus relative to the cost of driving and parking an automobile. Most automobile drivers were supplied with free or inexpensive parking at work. Ninety percent of those surveyed paid one dollar per day or less for parking.

Associated with the idea of parking costs, Wachs noted that out-of-pocket costs experienced several times per week by auto users (parking, tolls, gasoline, etc.) were psychologically given greater weights than the less obvious costs (depreciation, maintenance) and were associated more closely with the

work trip. Because the out-of-pocket costs can be split among carpool members, reducing the cost to each member to a fraction of what he would pay if driving alone, the benefits of carpooling may be made more evident to potential carpoolers.

Finally, Wachs observed that among the amenities believed to influence mode choice (carpeting, temperature control, tinted glass, seat assurance, music, and legroom), only temperature control and seat assurance were perceived by Shirley Highway commuters as important. A large number of automobiles today are being equipped with air conditioning as well as heaters, as are the majority of transit vehicles currently in use. However, whereas transit services cannot always guarantee riders a seat during peak periods, seat assurance is a basic element of carpooling.

In addition, many commuters dislike the impersonal atmosphere of the transit vehicle. In carpools, a more personal atmosphere is created by the presence of only a few individuals with whom the carpooler can converse and become better acquainted. It is worth mentioning that some commuters view this personal aspect as a barrier, feeling that they will experience a loss of privacy. Such a person would be not only unlikely to carpool but also unlikely to ride transit.

The previous paragraphs have shown how carpooling compares with transit according to various factors of attractiveness. The intent has not been to view carpooling as a replacement for existing transit systems; rather, the comparison was intended to demonstrate that carpooling is a feasible alternative in situations where transit service is either ineffective, impractical, or totally unavailable. Indeed, it is entirely possible in an urban area for widespread carpooling to coexist with transit, neither service drawing substantially from the other's market.

Davis et al. (1975) of the University of Tennessee found in a survey of Knoxville commuters that traditional CBD-oriented transit users are unlikely to change their mode of travel to work, given other alternatives. These commuters generally either do not have an automobile available for work trips or, despite having an automobile available, live in an area where it is more convenient and/or practical (in the commuter's mind) to use public transit. In either case, when home and work locations are perceived to be adequately

linked by transit, rarely do commuters feel it is more beneficial to carpool than to ride transit.

To the contrary, a survey of Knoxville express bus riders (unconventional transit) revealed that these users almost without exception did have an automobile available for the trip to work (Davis 1975). Only because the express bus, which may be considered as a form of carpool, offered less expensive, faster, more reliable service than the automobile did these commuters switch from their automobiles to the express bus. In fact, the typical express bus user drives to a park-and-ride facility, then rides the bus to his place of employment.

There is further evidence that carpools can coexist with transit without competing. Unlike conventional transit, carpools are not necessarily CBD-oriented. The growing number of businesses locating or relocating in suburban areas has resulted in the inability of transit to efficiently link a majority of residences with a majority of employment locations. Conventional transit operates along a relatively few fixed routes designed to accommodate high concentrations of CBD-oriented demand during peak hours. Contrarily, carpools are capable of reacting to low or moderate demands along many different routes. That is, transit is directed toward the general commuting needs of the entire population of an urban area while carpools are directed toward the specific commuting needs of small groups of people. Because express bus and vanpool services possess characteristics of several similar carpools combined, these commuting modes, rather than competing with carpools, may be considered as being different forms of carpools. In the case of the express bus, the local transit agency provides the vehicles and drivers. In addition to the attributes listed above, carpools can also be effective in linking CBD-oriented work trips which are originating in or destined to areas outside of transit service coverage. Transit remains necessary to accommodate the high CBD-oriented peak period volumes and low off-peak volumes for which carpools generally are not well suited.

Among the disadvantages associated with carpooling is the problem of matching potential carpoolers with similar commuting needs (origin, destination, work schedule) and compatible personalities. The remainder of this report will address this problem as well as others and discuss the carpooling incentives and single-occupant automobile disincentives which may be used to

aid carpool formation. The effectiveness and feasibility of each incentive will be discussed along with real world experiences and theoretical problems associated with the implementation of carpooling programs using these incentives. As we have attempted to establish in the preceding pages, carpooling appears to be desirable. This report will explore possible methods of increasing carpooling. Because each situation in the real world possesses a unique set of characteristics requiring a tailoring of incentives and programs to each urban area, this report will not offer a best solution. Finally, because past research has centered on carpooling primarily with respect to work trips, this report will view each incentive and disincentive in the context of the work trip. Although a few non-work trip carpooling program proposals have been advanced, research and experiences in this area are so limited that this paper will not deal with the topic.

INCENTIVES FOR CARPOOLING

Carpooling incentives are strategies that tend to increase carpooling directly, offering some kind of reward to carpoolers that lone automobile drivers cannot receive. These incentives may be employer-based, they may be travel cost-related, parking-related, or related to traffic regulation and control policies. Programs using carpooling incentives--as opposed to single-occupant automobile disincentives--frequently are not undesirable to the public. However, to elicit a significant response it has been found that widespread exposure and skillful promotion are required.

TWO RIDESHARING SYSTEMS

Carpool matching and promotion programs and vanpool programs are employer-based incentives which can be implemented almost immediately. Several such programs are currently operating in urban areas and have experienced essentially no public resistance. These programs have demonstrated moderate success.

Carpool matching and promotion involves programs in which participating individuals are matched with others according to their commuting needs. Each potential carpooler is given a list of others with similar commuting needs. Thus, the participant is given the opportunity to form a carpool; the decision is up to him or her. The elements that make matching programs attractive include the following: little time and expense are necessary to implement a program; the final decision to form a carpool is left to the individual; such programs are easily adapted to any scale of operation; and matching programs can easily be combined with other carpooling strategies to be discussed later.

In the typical matching scheme, the employer collects information on commuting needs from the employees by using a simple survey. The employer then either sends this information to an areawide matching center, which uses a computer to match potential carpoolers from the entire urban area, or keeps the information in order to match potential carpoolers within the company. Intra-company matching can be accomplished either manually or using company computers, depending on the size of the firm. If widespread interest is demonstrated in an urban area, cities may make a computer available to companies without computers, but requiring a computer for the matching process. In most cases where a company has enough employees to require computer matching, the company already has access to a computer.

Aerospace Corporation in El Segundo, California implemented such a matching program. Twenty percent of the employees not already carpooling applied for matching. Of these, 50 percent joined carpools which averaged 3.09 persons per vehicle (F.E.A. 1976). The cities of Portland, Oregon, Sacramento, and Knoxville all are engaged in areawide carpool matching and promotion programs that have proven to be very successful. In Portland, approximately one-third of the work force became involved. Three hundred fifty organizations employing 96,000 workers had matching programs. Table 1 gives the results of a survey of forty-six participating and three non-participating companies.

Table 1. Portland Carpool Survey

	Participating	Non-Participating
Total number employed	32,315	1,154
Surveys returned	9,667	431
Percent of employees carpooling six months after matching program began	34	17
Percent of employees carpooling before matching program began	21	11
Percent of employees joining carpools since matching program began	12	5

Source: Graham 1974, p. 83.

Two special points of interest may be obtained from this table. First, before the carpool matching programs even began, there appeared to be a stronger tendency to carpool among employees of companies who eventually implemented matching programs than existed among employees of companies choosing not to implement matching programs. Such an observation may point to topics for further research. Second, and possibly more significant, despite the choice of some companies not to implement matching programs, the carpooling rate among employees of these firms increased by more than 40 percent, apparently due to exposure to areawide matching through sources other than the employer.

The city of Sacramento implemented a matching program using two strategies in July of 1974. Along with the employer-based matching program, which was similar to that in Portland, Sacramento made available a dial-in matching service to commuters not exposed to the matching program through their employers. By March 1, 1975 (eight months later), 6,225 CBD workers had applied for matching through employers with an additional 998 commuters applying through the dial-in service. The total (7,223) represents about 14 percent of the approximately 50,000 CBD workers. When carpooling began, 19.3 percent of the employer-based applicants and 37 percent of the dial-in applicants joined and stayed in carpools. These newly-formed carpools averaged

3.2 occupants and the average commuting distance one-way was 18.4 miles (Jones and Derby 1976, pp. 40-41).

The experience in Knoxville involved primarily employees of the Tennessee Valley Authority (TVA), the major employer in Knoxville. Two surveys of TVA employees, in the fall of 1973 and December of 1974, provided before-and-after results for the Knoxville carpool matching program (Table 2).

Table 2. Knoxville Carpool Survey (by percent)

	Fall 1973	December 1974	March 1975
Non-ridesharers	56	36	28
Vanpoolers	0	2	2
Express bus users	0	13	17
Carpoolers	39	43	45
Traditional transit users	3.5	4	6
Others (bicycle, motorcycle, walk)	1.5	2	2

Source: Davis et al. 1975, p. 106

There do exist several negative aspects to carpool matching and promotion programs. To deal with these, the following elements must become an integral part of carpool matching policy. First, employers must be given a clearcut motivating force to initiate and join in carpool matching programs. Such motivating forces involve a wide range of incentives, from public image to monetary savings in parking facility costs. Second, legislation must be passed that will allow state and local transportation agencies to lead the way in establishing carpooling programs by setting an example. At present, many of these agencies are severely restricted in promoting or supporting programs of many varieties, one of which is carpooling. Liability in cases of accidents is the primary concern of restrictions on agency activities in carpooling. Finally, the most important aspect of carpool matching programs is that security must be maintained regarding information received from corporations and individuals that was intended solely for the purpose of commuter matching.

Vanpooling services can be organized by employers to provide low-cost high-occupancy commuting to employees. The most common forms of vanpool are those in which the company or an employee association owns or leases twelve-passenger vans, making them available to employees of a single company for commuting trips. Employees generally subscribe to the service for short periods of time, usually by the month. The vanpool driver is an employee of the same company as the riders and is allowed low-cost private use of the vehicle during non-work hours in return for driving and maintaining the van. Rider fares are usually mileage-based and are designed to cover all capital and operating costs of the van during each subscription period. Low fares are guaranteed by requiring the vanpool driver/coordinator to maintain a minimum number of riders for each subscription period (Owens and Sever 1974).

Like carpool matching and promotion programs, vanpooling has been demonstrated as being practicable in many locations. The 3M Company in St. Paul, possessing one of the oldest and most successful programs in operation, began its program with six vans. In two years the vanpooling concept had become so popular among 3M employees that 75 vans were being used with long lists of employees waiting to join. In late 1975, these 75 vans carried 800 people with an additional 400 employees on waiting lists. At that time, 800 persons was 9 percent of the 3M work force. Half these vanpoolers were former carpoolers. The remaining half were drivers of single-occupant automobiles. In a survey of vanpoolers attitudes toward the program, 97 percent stated they were satisfied. 3M reported that between 1970 and 1974 the number of employees rose 23 percent (from 7,730 to 9,485) while the number of parking spaces required fell 1.4 percent (from 6,234 to 6,146). Also during this time vehicle occupancy increased from 1.24 persons/vehicle to 1.54 persons/vehicle (Owens and Sever 1974).

Other companies--Cenex and General Mills in Minneapolis-St. Paul; Texas Instruments, Aerospace Corporation, and Conoco in Houston; and Scott Paper Company in Philadelphia--and governmental agencies--the California Department of Transportation, the city of Los Angeles, and TVA in Knoxville--have also developed successful vanpool programs. More than thirty other companies and agencies have either begun programs or are in the final planning stages of vanpool programs.

Several elements of vanpool programs make them attractive. Employers who presently provide parking for employees can save money on parking facility costs and maintenance. 3M estimates they saved three million dollars when plans for a new parking garage were abandoned in favor of a vanpool program (Commonwealth 1975). The capital costs of the vans purchased or leased by the employer are recovered through fares paid by the riders. Also, less than one year is required to move a program from conception to operation. Most of this time is spent assessing employee commuting needs, studying the feasibility of such a program, and waiting for the vehicles to be delivered after they are ordered.

Before vanpools can contribute substantially to the reduction of the peak period problems discussed earlier, some problems must be addressed. First, since employers are the logical sponsors of vanpool programs, a large number of employers must somehow be motivated to introduce vanpool programs. As with carpool matching and promotion, appeals related to cost savings and public image might be effective. Second, since not all employees may be accommodated by the vanpool program, labor unions may argue that vanpoolers are subsidized by the company and may demand that non-vanpoolers be compensated. In this case, the program has become a labor union bargaining item, something the employer sees as a disincentive to starting a vanpool program. Special legislation prohibiting the consideration of vanpools in labor contracts should dispel employers' fears on this subject. Third, although all evidence collected thus far indicates that most vanpools operate in areas not well-served by transit, further efforts must be made to convince transit authorities and associated labor unions that vanpools do not represent significant competition to conventional transit. Finally, many states require drivers of high occupancy vehicles, including vans carrying twelve or fifteen passengers, to acquire a special driver's license. If 3M may serve as an example, this requirement, which exists in Minnesota, does not represent a significant obstacle. Indeed, such a requirement may assure the passengers of a greater degree of safety. As an alternative, some states may wish to introduce legislation that will exempt vanpool drivers from such a requirement.

OTHER INCENTIVES FOR CARPOOLING

Offering financial incentives to employers and individuals who form vanpools is an additional incentive which has not yet been implemented. Such financial incentives may be special tax credits or accelerated depreciation allowances for employers and income tax credits for individuals. These credits and allowances could best be administered by the federal government; however, because a permanent incentive program of this type would probably necessitate an increase in other taxes (in order to recover revenue lost through the program), the incentive must be offered for a limited time only, long enough to stimulate vanpool growth.

As the reader may have suspected, such an incentive requires special tax legislation which may be difficult to pass. Before such legislation is enacted, evidence and estimates of the program benefits must be collected. To date the only related piece of evidence is that the Gallup and National Opinion Research Center found that decreased costs for ridesharing is a popular idea (Highway Users 1975). Congress and the Internal Revenue Service may offer resistance to tax policies that will complicate tax codes to a further degree. Finally, transit agencies and associated labor unions are likely to protest any form of federal vanpool subsidies; thus, these two interest groups must be accounted for in any analysis of the potential use of financial incentives.

Carpool cost subsidies is a ridesharing incentive that has been used only on a limited basis but which shows great potential. The Port of Portland, Arundale Manufacturers in St. Louis, AiResearch in Phoenix, Prudential Insurance Company in Newark, and the Sacramento Regional Planning Commission all have developed carpool programs using this incentive (F.E.A. 1976). Carpool subsidies are payments by the employer to employees for using various forms of ridesharing. The arrangements for payment are various. The employer may make a direct cash payment to all persons commuting in a carpool of a specified size or larger. These payments may be either on a daily or a monthly basis and are based on mileage traveled and/or carpool size. The employer may subsidize all or part of a company-sponsored vanpool program. Such subsidization would be aimed at lowering or eliminating fares paid by users. The employer may choose to give special awards to carpoolers in the form of

fringe benefits such as bonus vacation days, drawings for prizes or savings bonds, or company-arranged discounts at local stores.

Among the problems associated with carpool cost subsidies is the fact that implementation of such a policy is by nature dependent on the employer. It may be difficult to find ways of motivating large numbers of employers to undertake a program of this type. The employers mentioned generally followed the rule of subsidizing only to the extent that employee carpooling benefited the employer (for example, parking supply costs reduced). Also, such programs seem to be effective only in densely populated urban areas where the cost of providing parking facilities is high and where the employer can at least break even in providing subsidies. In addition, as with some other employer-based incentives, employers may hesitate to implement a carpool subsidy program fearing that labor unions will use the program as a negotiating item. The same safeguards against such actions as mentioned previously would probably be necessary before widespread use of carpooling subsidies occurs. Finally, government agencies which currently cannot implement carpool subsidy programs because of possible liability claims could set an example for area employers to follow. However, in order for this to occur, special legislation must be passed defining the limits of liability the agency is subject to. Since carpooling is currently not a major issue, such legislation seems unlikely in the near future.

The adoption of variable working hours has been proposed as another incentive to carpooling. The attractiveness of such an incentive is manifested primarily in its short implementation time and its low cost to participating employers. The primary objectives of varying work hours as related to carpooling are to lengthen peak periods, thereby reducing the degree of congestion during peak periods, and to allow potential carpoolers the flexibility in their work schedules that may be required in order to carpool with others.

The concept of variable working hours has been tried in New York; Philadelphia; Washington, D.C.; Ottawa, Canada; and Nagoya, Japan; as well as in several European cities. In all cases, the desired result was to diminish transit usage peaks rather to substantially increase carpools. And in each case transit peaks were diminished by implementing variable working hours. Only in Ottawa was a study carried out related to carpooling. That study revealed that the short-term effect of variable working hours on mode choice and auto occupancy was insignificant (Sefavian and McLean 1975). Further, a

theoretical analysis by the United States Department of Transportation found that variable work hours, though not directly related to carpooling, do affect carpooling negatively, decreasing the tendency to carpool. The same analysis found, however, that the benefits to transit of variable work hours more than offset the negative impact on carpooling (F.E.A. 1976).

In view of the results of these studies, it is certainly questionable whether or not varying work hours is an incentive to carpooling. Perhaps variable working hours would become more effective if combined with other incentives and disincentives associated with carpooling. Above all, before any policy linking carpooling and variable working hours is adopted, the relationship between the two must be investigated further and in greater depth.

Mandatory carpool programs have been tried on a limited basis only. This incentive represents a government action in which employers having greater than a specified number of employees are required to adopt a carpool promotion program. Boston requires employers with fifty or more employees and educational institutions with 250 or more commuters to implement some type of ride-sharing program. Such programs may involve publicizing various aspects of transit service, offering bicycle incentives, or making parking restrictions known. Employers with at least 250 employees and educational institutions with at least 1,000 commuters are required to have carpool matching programs. In addition, employers are required to file periodic reports regarding the commuting habits of employees and the state of the carpool action plan (F.E.A. 1976). The Colorado Air Quality Commission has adopted standards similar to those of Boston (F.E.A. 1976). These two represent the only attempts at instituting mandatory carpooling programs in the United States.

Though no evaluations have been performed concerning the effectiveness of this incentive, several problems related to the concept have arisen. Employers consistently fight against any attempts to increase government regulation over them; therefore, employers can be expected to be stubborn in accepting the idea of mandatory programs. As a result, every effort must be made by government agencies to assist employers in tailoring carpool programs to fit each employer's particular needs. The Masspool concept, developed in Massachusetts, is a good example of this type of government assistance (Commonwealth 1975). Also, it is not safe to assume that opinions regarding

mandatory programs will be as favorable as those associated with a voluntary program. Therefore, a survey designed to estimate the feasibility of mandatory carpool programs should be carried out in urban areas where using such an incentive is being considered.

Preferential traffic control is an incentive with characteristics quite different from those already discussed. It is designed to save time for commuting carpoolers by giving them special rights. Currently in use successfully in many locations and in several forms, preferential traffic control has excellent potential for extensive use in the future. Studies at locations where such incentives are used reveal that the concept is both effective and popular. Costs of implementing such policies are generally low and the time required, approximately one year, is minimal. Furthermore, individual locations using this incentive in a single urban area may be integrated to form an overall regional carpooling development pattern in a relatively short time.

Exclusive freeway lanes, constructed within an existing freeway right-of-way and physically separated from general traffic, may be assigned to buses and carpools meeting minimum occupant requirements. The Shirley Highway into Washington, D.C. demonstrated a large increase in both transit ridership and carpooling after its exclusive lane was opened to bus and carpools with four or more occupants (F.H.W.A. 1974).

Preferential freeway lanes are existing freeway lanes that are converted daily to preferential lanes for buses and carpools of specified sizes during peak periods. The approach lanes to the San Francisco-Oakland Bay Bridge toll plaza, Moanalua Freeway in Honolulu, and the I-93 Freeway in Boston are examples of this type of preferential traffic control. Most freeways adopting this incentive, especially those coupled with reduction or elimination of tolls for carpools, have been very effective in increasing the rates of transit ridership and carpooling (F.E.A. 1976).

Contraflow lanes are preferential lane schemes in which one lane of a freeway is used by buses operating in the opposite direction of the intended flow (for example, using an outbound lane for inbound buses during the morning peak). The primary concern with such an incentive is safety. For this reason a buffer (unoccupied) lane is used between the innermost normal flow lane and the contraflow lane. Only in Honolulu has a contraflow lane been opened to

carpools (F.E.A. 1976). Accident experience with contraflow lanes has not been significantly different from regular flow lanes; therefore, contraflow lanes may receive increasing future application.

The final popular preferential treatment scheme is the use of preferential entrance ramps, in which carpools of specified occupancies (most often three persons) are allowed to bypass ramp meters through the use of a carpool-only entrance lane. In the Los Angeles freeway system many entrance ramps have been provided with preferential treatment for carpools. In a survey of users of these preferential ramps it was found that a large number of commuters have joined carpools for the sole purpose of avoiding long queues (of approximately five minutes) at metered ramps (Goodell). The lack of success of the preferential ramp lane to I-35W in Minneapolis has been attributed to the lack of delay experienced by non-carpools (rarely more than one minute) and the circuitous path which must be followed in order to reach the preferential lane (Benke 1975). Other preferential traffic control techniques have been applied to transit service but are not applicable to carpooling.

Two minor obstacles must be overcome before widespread use of preferential traffic control on urban freeways is realized. First, highway departments and city traffic engineers must be convinced that preferential control policies represent a feasible partial solution to existing freeway problems. Second, periodic enforcement of preferential facilities is absolutely necessary in order for the rate of carpooling to increase substantially. In Los Angeles, enforcement once every four or five weeks proved to be adequate in holding down violation rates (Goodell).

Preferential parking for carpool vehicles is another concept which exhibits potential. Under this incentive, several different techniques may be used. If parking is scarce, carpoolers may be guaranteed a parking space. In large parking lots, employers may assign to carpoolers those spaces nearest the buildings. If both indoor and outdoor parking is available, carpoolers may be assigned as many indoor spaces as possible. Finally, employers may decide to assign reserved spaces with nameplates to carpoolers. Among those who have had great success with preferential parking are the National Aeronautics and Space Administration (NASA) and the United States Department of Transportation in Washington, D.C., the Government Employees Insurance Company,

General Electric, and Southern New England Telephone. The Pentagon, which began using preferential parking as a carpool incentive in 1970, now has more than 5,000 registered carpools and 80 percent of Pentagon employees share rides (F.E.A. 1976, p. 97).

The most attractive feature of preferential parking, as compared with other incentives, is that no major obstacles are associated with its implementation. Employers with more parking spaces than are needed may resist somewhat, but this resistance should not be expected to be substantial. A Gallup poll revealed that 65 percent of the public would favor some form of preferential parking on a large scale (F.E.A. 1976, p. 99).

Another parking-related incentive which has immediate practical possibilities is the use of carpool parking subsidies. With this incentive subsidies covering all or part of the parking costs are paid to carpoolers. As with most other carpool-related subsidy programs, this program is operated most effectively by the employer. Because many employers currently provide their employees with free parking and would be hesitant about instituting parking charges on solo drivers, efforts to persuade employers to provide parking subsidies should be focused upon those that do not provide free parking. Currently two Boston insurance companies, the Port of Portland, and the cities of Seattle and San Diego are using carpool parking subsidies (F.E.A. 1976). Programs in which periodic payments of cash are made to carpoolers have become very popular. In those cases where free parking spaces are being provided for carpoolers, demand for these spaces has exceeded supply.

Among the obstacles associated with carpool parking subsidies is that this policy seems applicable only where parking costs are high, leading to a substantial savings in parking expenses. Second, since such a program is employer-based, it is voluntary. Despite public popularity of the policy, it seems unrealistic that a large number of employers can be sufficiently motivated to implement a program in which the benefits to the company are questionable. Finally, as with some of the other incentives, employers may fear that the subsidy will become a bargaining item in negotiating labor contracts.

The final incentive to be considered here, the offering of carpool tax incentives, has not yet been attempted anywhere in the world. This incentive involves granting carpooling individuals income tax credits of deductions. A flat deduction could be offered based on whether or not the person carpooled a specified number of times during the year. Variable deductions or credits might also be based on the number of days a ride was shared, on the total number of passengers carpooling, or on the number of passenger-miles of carpooling service supplied.

For such a policy to be introduced, major tax legislation must occur at the state or federal level. Before such legislation is possible, positive evidence of the benefits of the program must be demonstrated. State legislatures, Congress, and the Internal Revenue Service can be expected to oppose such legislation due to substantial decreases in tax revenue. Also, before such legislation is considered, the problem of validating claims of carpooling frequency must be addressed and solved. This burden of validation would most likely fall on employers, who would strongly protest such a demand. For these reasons the probability of carpool tax incentives coming into use before other incentives is very small.

DISINCENTIVES FOR THE SINGLE-OCCUPANT AUTOMOBILE

Single-occupant automobile disincentives are strategies that tend to increase the rate of carpooling indirectly by making the use of the automobile as a single-occupant carrier unattractive. As with the incentives, these disincentives may be related to travel costs, parking, or traffic regulation and control. Because disincentive programs remove some of the attractiveness from driving alone--rather than adding to the attractiveness of carpooling--they are much less popular than incentive programs. However, despite their unpopularity, many disincentives are much more effective in increasing carpooling than incentives are. For this reason, it may become practical to combine a number of incentives with a single effective disincentive. Following are descriptions of eight different disincentive programs that may be important to consider.

Area restrictions is a disincentive which may be used in the future in the United States but has not been demonstrated to be strongly related to carpooling. As presently used in Europe and the Far East, area restriction is a system whereby certain parts of an urban area, most often the central core, are set aside as restricted zones where various limitations are placed on travel mode and parking. Techniques employed in operating the restricted area include diverting traffic around the area, allowing only carpools of specified sizes within the area, improving transit service to and within the area, developing pedestrian and bicycle routes, reducing the amount of parking in the restricted area, and closing a large number of the area's intersections. The results of such techniques have been to increase safety, improve bus travel times, decrease automobile traffic, and increase vehicle occupancy. Also, somewhat surprisingly, public reaction has been positive regarding area restrictions (F.E.A. 1976).

Several attributes of area restriction make its implementation in the United States difficult. Massive planning efforts and studies must be undertaken before implementation of area restrictions takes place. Primarily because authority is widely distributed and because large quantities of money are unavailable for massive projects, the ability of United States planners to conduct such studies and have their proposals implemented is questionable. Also, despite evidence to the contrary in Europe and the Far East, businesses located in the core area are likely to oppose such programs on the grounds that businesses will be adversely affected by area restrictions.

Federally-imposed gasoline rationing is felt to be the most effective disincentive related to carpooling. The Federal Energy Administration (FEA) has proposed a 25 percent reduction in gasoline consumption if rationing becomes necessary. Rationing during World War II decreased by one-third the number of vehicle-miles traveled. Unfortunately, World War II represents the last experience with rationing, so that the effects of rationing now are open to speculation. Under a rationing system, ration coupons would be distributed quarterly at post offices. In addition, the price of gasoline would increase substantially and a fee would be charged each time coupons were distributed.

The imposition of gasoline rationing presents many problems. Federal legislation would be necessary. The FEA estimates that the large bureaucracy required (15,000-25,000 new government employees) would necessitate a lead time of four to six months. In addition, if large numbers of drivers applied for extra rations, the administrative machine would become unwieldy. Finally, the problem of ration coupon counterfeiting must be considered and dealt with.

A one-day-a-week driving ban is a program under which drivers are allowed to drive only six days per week. The selection of the one non-driving day may be based on the driver's choice, in which case a sticker on the car identifies that day, or it may be based on the automobile license plate number, in which case the driver is given no choice. As with gasoline rationing, legislation is necessary to implement this policy. Since the FEA estimates the decrease in fuel consumption would be less than 5 percent and because enforcement and administration of the program, as in cases of multi-car families, would be difficult, there is little chance that such legislation will receive much attention in the near future. The FEA also has recognized that one-day-a-week driving bans, along with gasoline rationing, are the least popular disincentives among the American public and has recommended that these policies be used only as emergency measures.

The elimination of employee parking subsidies is recognized as one of the more practical disincentives associated with increased carpooling. It can be easily implemented once the decision to use such a policy has been made. Under this plan employers voluntarily eliminate or reduce free parking to employees whether or not those employees belong to a carpool. The theory behind this disincentive is that if employees must pay to park their vehicles at the employment site, they will be more likely to look for others to share rides with them in order to split parking costs. It is suggested that employers use the current subsidy (money paid by the employer in maintaining and owning free parking spaces) to give employees a uniform pay increase or to create alternative transportation opportunities when the subsidies are eliminated. Also, when employers build new facilities they may consider providing less parking than they previously provided. The 3M Company in St. Paul, the only company to have attempted elimination of parking subsidies thus far, began charging fifteen dollars per month to park in their company garage. Simultaneously,

the company offered its vanpool program to all its employees (F.E.A. 1976). The chief problem with such an employer-based program is employer reluctance based on the fear that, despite receiving increases in pay, employees will strongly oppose paying for previous free parking.

A government-initiated variation of this type of program is to reduce or restrict the supply of public parking by placing occupancy restrictions on commuter vehicles, allowing only vehicles with a specified number of occupants to park in public facilities during peak hours. Both Boston and San Francisco have begun programs which reduce the availability of public parking.

The implementation of such a program would be left to municipal governments. The difficulties associated with implementation include fragmentation of parking authority in cities, reductions in revenue to owners of pay parking facilities, and the inability to control parking facilities owed by companies and provided for employees. A possible alternative to reducing parking facilities is to halt parking facility growth. This approach would be much more acceptable to the public.

Pittsburgh demonstrated, during a parking facility strike affecting 80 percent of the parking supply, that large parking supply decreases can be accomplished. There, most displaced parking patrons used transit and, incredibly, not all parking facilities that were open were filled. However, the large decrease in parking did adversely affect retail sales slightly and theater and restaurant businesses greatly (Hael and Roszner 1972). Therefore, caution should be exercised in cities where reductions in parking supply are being considered.

A highly unpopular parking-related disincentive is to initiate parking tax surcharges. The concept here is to increase the total price paid for parking substantially. Such a program, established by local governments, would be in the form of either a flat surcharge (for example, one dollar per vehicle per day) or a percent surcharge (for example, 50 percent tax on the cost of parking). The implementation of this program may be coordinated with the elimination of employer-provided free parking or with carpool subsidization. San Francisco, London, Singapore, and Glasgow all have attempted using parking tax surcharges. However, the decrease in the number of parked cars during any given period was nearly imperceptible (F.E.A. 1976). Due to this

questionable causal relationship, the unpopularity of the policy, and the probable resistance from employers providing free parking, the use of parking tax surcharges is not viewed as a viable alternative at present.

Area or facility tolls are another form of carpooling disincentive which show potential for use in the immediate future. Under this scheme tolls are imposed on low-occupancy vehicles driving on facilities where no toll is presently charged. A variation of this idea is to introduce differential tolls which depend on vehicle occupancy at existing toll facilities. Fixed point collection, similar to current toll collection facilities, and area licenses, permits purchased periodically (from daily to monthly) which allow drivers to drive in a particular area, are two forms of facility and area toll enforcement. The port authority of New York and of New Jersey raised the toll 50 percent to low occupancy vehicles (one or two passengers) while simultaneously lowering by 50 percent the toll to higher occupancy vehicles. According to a Port Authority official, these toll changes had little or no effect on carpool frequency or auto occupancy (F.E.A. 1976). Singapore is so far the only city in which area restriction licenses have been used. There a drastic reduction in CBD trips was experienced. The number of automobile trips declined 76 percent while the number of trips by other vehicles fell 23 percent (F.E.A. 1976).

If area or facility tolls intended to increase the rate of carpooling are to be used widely and effectively in the United States, state and local legislation must be passed (retailers probably would protest area tolls), the effectiveness of the particular proposal must be demonstrated, and public opinion on the subject must change.

Another disincentive which might increase carpooling, gasoline tax increases of ten to thirty cents per gallon, has little chance of implementation. Such increases would require extremely unpopular state or federal legislation. Also, the effect of a large gasoline price increase on carpooling is questionable. Previous to the 1973-74 energy crisis, gasoline sales were expected to increase 9 percent during this period. Because of the energy crisis, actual sales were 12 percent below these expectations. This represents only a 4 percent real decrease in sales resulting from a 60

to 75 percent increase in price. In addition, the major share of the reduction resulted from the elimination of trips, mostly shopping and recreational trips, rather than from increased commuter vehicle occupancy (F.E.A. 1975). Finally, the reduction in gasoline sales was associated more with the decreased availability of gasoline during the energy crisis than with the increase in price (Peskin 1975). This revelation casts further doubt on the effect of gasoline price increases.

The final disincentive to be discussed here is that of vehicle purchase or registration taxes, whereby taxes based on vehicle price, weight, horsepower or engine size, fuel economy, emissions rating, and/or the number of vehicles in the household are assessed either at the time the vehicle is purchased or annually at the time the vehicle is licensed. To be significantly effective, the FEA estimates such taxes must be between 200 and 400 dollars per vehicle per year. This very unpopular disincentive will probably not receive much attention in the near future as a means of increasing carpooling. The reasons include: vehicle purchase and registration taxes have been linked only indirectly to carpooling frequency through the concept of automobile ownership; federal or state legislation requiring a five to ten year transition period for full effectiveness must be passed; such legislation would be extremely unpopular; and the powerful automobile industry will strongly oppose any measure which will make their product more costly as perceived by the public. Rather than being used as a means of increasing carpooling rates, vehicle purchase or registration taxes may come into use primarily to decrease automobile ownership and to increase the fuel economy of the average automobile.

IN CONCLUSION

As has been noted, there exist many possible incentives and disincentives which may be used either alone or in combination to increase the rate of carpooling in this country. Associated with each technique is a series of limitations and attributes which may be viewed as either attractive or unattractive. Metropolitan areas considering methods to increase carpooling should carefully study the assets and liabilities associated with each method and select the technique or set of techniques which best fit that urban area's unique collection of needs.

BIBLIOGRAPHY*

Anderson, D. L. and Clift, J. M. March 1974. Auto occupancy on U.S. work trips: a comparison of findings from the nationwide personal transportation survey. Research Paper RP-SP-36. Campbridge MA: U.S. Department of Transportation, Transportation Systems Center.

Andrle, Stephen and Dulker, Kenneth J. August 1974. Attitudes toward and evaluations of carpooling. Technical Report No. 32. University of Iowa: The Institute of Urban and Regional Research.

Atherton, Terry J.; Suhrbier, John H.; Jessiman, William A. October 1975. The use of disaggregate travel demand models to analyze carpooling incentives. Draft. Cambridge MA: Cambridge Systematics, Inc.

Chains together auto ownership, work trip mode choice, and non-work travel demand and relates effects of each different policy.

Barb, Charles E., Jr. and Roach, William T. January 1976. Information support development for paratransit planning for major urban activity centers. Paper presented at the 55th Annual Meeting of the Transportation Research Board.

Results of attempt to enlist Seattle hospital workers in pool programs. Shortcomings of plan.

Barton-Aschman Associates. March 1970. Commuter parking at highway interchanges. [PB192006]

Bather Wolsfeld, Inc. August 1975. I-35W urban corridor demonstration project: final report for U.S. Department of Transportation and the Metropolitan Council of the Twin Cities Area. [PB247663]

Ben-Akiva, Moshe E. and Atherton, Terry J. January 1977. Choice model predictions of carpool demand: methods and results. Paper presented at the 56th Annual Meeting of the Transportation Research Board, Washington D.C.

Four models used in order to determine effects of various policies on carpooling decisions.

Benke, Robert J. July 1975. Preferential treatment for carpools on I-35W. Study #07-135. St. Paul: Minnesota Department of Transportation, Office of Traffic Engineering.

Problems encountered using buses' access ramp for carpools. Importance of a delay to promote carpooling.

* Numbers in brackets indicate the document number at the National Technical Information Service (NTIS): U.S. Department of Commerce; 5285 Port Royal Road; Springfield, Virginia 22161.

Benke, Robert J. October 1976. Ramp meter bypass for carpools. Report #07-58-763. Washington D.C.: Federal Highway Administration, Office of Research and Development.

Changes in ten variables when carpoolers are allowed to use ramp to bypass metering.

Benke, Robert J. and Sjoberg, Robert A. May 1976. Auto occupancy parameter variations: a study of seasonal, daily, and long-term variations in auto occupancy parameters. Study #07-132. St. Paul: Minnesota Department of Transportation, Office of Traffic Engineering, Traffic Systems and Research Section.

Variations by season, by day, by corridor. Defines auto occupancy rate, people loading rate, auto loading rate.

Cambridge Systematics, Inc. November 1976. Guidelines for travel demand analyses of program measures to promote carpools, vanpools, and public transportation. Washington D.C.: Federal Energy Agency, Office of Policy and Program Evaluation.

Worksheets and how to use them to find pool demand possibilities, areas of promotion, effects on energy consumption.

Cambridge Systematics, Inc. and Voorhees, Alan Assoc. June 1976. Carpool incentives: analysis of transportation and energy impacts. Washington D.C.: Federal Energy Administration. [PB263969]

Discusses evaluations of probable energy impacts of various policies using three models (described in Appendix) in a sequence: auto ownership, work-trip, non-work travel demand. Lists variables needed for each. Finds most effective policy.

Capelle, D. G.; Wagner, F.A.; Henning, D.J.; and Morin, D.A. 1972. Feasibility and evaluation study of reserved freeway lanes for buses and carpools. Highway Research Record 388: 32-44.

CENEX. 1975. Does your pool runneth over? Dip into our commute-a-vans. St. Paul: Farmers Union Central Exchange Inc. (1185 N. Concord St., South St. Paul, MN, 55075)

Complete list of benefits, driver qualifications, good and bad aspects.

Chandrasekaran, R. and Rao, S. Subba. June 1974. A carpooling problem. Cleveland: Case Western Reserve.

A purely statistical approach to the problems of carpools. Assumes that probabilities of missing carpool, for example, have known values or estimates. Proof leads to conditions under which pools are to be formed.

Commonwealth of Massachusetts. November 1975. Masspool: a handbook for employers. Boston: Department of Public Works, Executive Office of Transportation and Construction.

In-depth carpooling program proposal aimed at the employer. Includes information on organization, creating incentives, choosing matching

method, introduction of program to employees, maintaining a program, vanpooling, cooperation with transit agencies.

Commonwealth of Massachusetts. July 1976. Masspool: a vanpool program guide. Boston: Department of Public Works, Executive Office of Transportation and Construction.

In-depth employer-operated vanpool program. Information on organization, route identifications, driver selection, van acquisition, fare calculation, pool assembly. Examples of successful vanpool programs.

_____ September 1976. First periodic status report of Boston employers' compliance with the transportation control plan requirements. Report to the Environmental Protection Agency from Boston: Department of Public Works, Executive Office of Transportation and Construction.

Categorizes by degree of compliance, number of employers attempting to achieve 25 percent reduction in single-occupant commuting vehicles.

Corder, Robert Gibson. 1974. The Parham express bus project. Traffic Engineering. 44(12): 14-17.

Park and ride facility in Richmond, VA. Explains how they did feasibility study.

Davis, F. W., Jr.; Bell, T. L.; Barnaby, D. J.; Fowler, O. S.; Hood, T. C.; Kurth, S. B.; and Wegmann, F. J. August 1975. Ridesharing and the Knoxville commuter. Knoxville: University of Tennessee, Transportation Center. [PB247146]

Knoxville ridesharing program. Concentrates on express bus operations. Mentions type of person who rides express bus. Includes employer reasons for not participating.

Davis, F. W., Jr.; Barnaby, D. J.; Bell, T. L.; Hood, T. C.; and Wegmann, F. J. January 1977. Increased transportation efficiency through ridesharing: the brokerage approach. Vol. 1, Final Report. Washington D.C.: U.S. Department of Transportation, Office of the Secretary. [PB267546]

Lists benefits to employers, commuters, community. Characteristics of ridesharing brokerage (promoter). Principles to follow in setting up brokerage operation.

FEA (Federal Energy Administration). February 1975. National petroleum product supply and demand. Technical Report 75-2. Washington D.C.: Federal Energy Administration.

_____ March 1976. Carpool incentives: evaluation of operational experience. Conservation Paper 44. Washington D.C.: U.S. Government Printing Office, Stock #041-018-00122-1.

Excellent report on programs and their use of incentives. Relates strategies and policies to applicable programs and the likelihood of implementation.

FHWA (Federal Highway Administration). January 1974. Preferential treatment of high-occupancy vehicles. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration, Urban Planning Division.

Samples of what is being done.

_____February 1975. Carpool incentives and opportunities. Report to the U.S. Congress. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.

FHWA and the Highway Users Federation. May 1975. How to pool it. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Focuses on employers. Explains management's role, types of pools, assembling a program, selling a program to employees, legal aspects.

Goodell, Robert G.B. Undated. Preferential access for multi-occupant vehicles at metered on-ramps. Sacramento: California Department of Transportation, Freeway Operations Branch.

Los Angeles area public response. Enforcement necessary to maintain workability.

_____October 1975. Experience with carpool bypass lanes in the Los Angeles area. Bypass lanes for carpools at metered ramps: a summary report. Sacramento: California Department of Transportation.

Discusses changes achieved in number of pools and vehicle occupancy. Gives responses to survey of reasons for carpooling.

Goodman, Joseph M. 1970. Operation of a freeway priority system for buses and carpools. Traffic Engineering. 40(7): 30-37.

Eleven different techniques for developing priority lanes.

Goodman, Leon. 1974. Bus rapid transit has made tremendous progress in past two decades. Traffic Engineering. 44(4): 32-39.

Describes various bus projects underway in U.S.--including priority lanes and ramps, and new types of buses.

Graham, Jack. December 1974. Portland metropolitan area carpool project. Salem: Oregon Department of Transportation. [PB245857]

Heaton, Carla. December 1973. Preliminary evaluation of the Boston area carpooling program (WBZ/ALA Commuter Computer Campaign). Cambridge MA: U.S. Department of Transportation, Transportation Systems Center.

Highway Users Federation for Safety and Mobility. 1974. The "pool it" work kit. Washington D.C.: Highway Users Federation for Safety and Mobility.

Description of kinds of pools, services of the federation, legal aspects. Complete assemblage of matching techniques which may be used and characteristics desired in setting up a pooling program.

Highway Users Federation for Safety and Mobility. Undated. Carpools and buses - two ways to cut commuting costs and ease traffic congestion. Washington D.C.: Highway Users Federation for Safety and Mobility.

General carpooling pamphlet, also vanpooling, bus transit. Companies that encourage pooling. Incentives. Bus lanes. Private buses.

Hoel, L. and Roszner, E. December 1972. The Pittsburgh parking strike. Pittsburgh: Carnegie-Mellon University. [PB213798]

Horowitz, Abraham D. and Sheth, Jagdish N. January 1977. Ridesharing to work: a psychosocial analysis. G.M. 2216. Warren, Michigan: General Motors Research Laboratories.

Concludes change is possible since average solo driver is neutral concerning ride-sharing.

Huss, Roger G. 1976. University of Minnesota computerized carpool service, winter quarter, 1976, survey results. Minneapolis: University of Minnesota Transit Services.

Students pool to: conserve fuel, relieve congestion, reduce pollution, save money.

Jones, Bill and Derby, Jack. 1976. Sacramento carpool project: interim evaluation report. In Innovations in Transportation System Planning. Transportation Research Record 619. Washington D.C.: National Academy of Sciences.

Keck, Carol A.; Erlbaum, Nathan; Milic, Patricia L.; Trentacoste, Michael F. August 1974. Changes in individual travel behavior during the energy crisis, 1973-74. MYDOT Preliminary Research Report 67. Albany: New York Department of Transportation.

Carpooling did not increase significantly enough to change auto occupancy rates.

Kendall, Donald C. June 1975. Carpooling: status and potential. Cambridge MA: U.S. Department of Transportation, Transportation Systems Center. [PB244609]

Kendall, Donald and Brevard, J. December 1973. Auto occupancy and the national level of carpooling. Research Paper RP-SA-14. Cambridge MA: U.S. Department of Transportation, Transportation Systems Center.

Kidder, Alice E.; Morgan, Bruce; and Saltzman, Arthur. 1976. Public response to carpooling programs. Transportation Engineering Journal. 102(August): 571-83.

Importance of employer participation. Travel time versus travel cost. Lead time necessary for implementation of program.

Kozar, Kathryn. November 1973. University of Minnesota carpool interim report. Minneapolis: University of Minnesota Transit Services.

Includes promotion, incentives, applications, computer programs and preliminary results.

Kurth, Suzanne B. and Hood, Thomas C. December 1976. Carpooling program: solutions to a problem? Paper presented at the 56th Annual Meeting of the Transportation Research Board. January 1977.

Effectiveness of various appeals to get people pooling.

Link, Dan. 1975. Planning for bus/carpool bypasses at metered freeway ramps. Traffic Engineering. 45(11): 32-35.

Summary of effort being made in California to encourage carpooling through preferential treatment.

Liston, Lawrence L. and Gauthier, C. L. April 1974. Cost of operating an automobile. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Metropolitan Council of the Twin Cities Area. April 1974. A summary report of travel in the Twin Cities metropolitan area. St. Paul: Metropolitan Council, Transportation Planning Program.

_____1975. Proposed metropolitan transportation development guide. St. Paul: Metropolitan Council.

_____1977. Transportation development guide/policy plan. Report # 35A. St. Paul: Metropolitan Council.

Metropolitan Transit Commission. December 1974. Transit revenue alternatives. A special report to the 1975 Minnesota Legislature. St. Paul: Metropolitan Transit Commission.

_____January 1975. Promotion of ridership in the metropolitan area: increasing the use of multi-occupancy vehicles. St. Paul: Metropolitan Transit Commission.

_____November 1975. Multi-occupancy vehicle usage in the metropolitan area. St. Paul: Metropolitan Transit Commission.

Trends in auto occupancy in the Twin Cities area. Percentage of daily non-work trips. Attempts at increasing transit and paratransit usage. Effectiveness of auto disincentives. Area legislative requirements.

_____November 1976. Paratransit. Draft. St. Paul: Metropolitan Transit Commission.

Results of numerous Twin Cities area pool programs, format of programs. Goals of Twin Cities area. Express bus service.

Mikolowsky, W. T., et. al. December 1974. The effectiveness of near term tactics for reducing vehicle miles traveled: a case study of Los Angeles region. P-5336. Santa Monica: Rand Corporation.

Miller, Gerald K. and Green, Melinda A. February 1976. An analysis of commuter van experience. Washington D.C.: Urban Mass Transportation Administration. [PB252304]

Explores kinds of existing programs, benefits, and motivations. Compares vans and buses and where the greatest potential lies. Characteristics of a good program.

_____ February 1976. Guidelines for the organization of commuter van programs. (for the Urban Mass Transportation Administration) Washington D.C.: The Urban Institute.

How to determine feasibility, promotion, organization, ongoing administration. Lists and describes a large number of programs.

_____ 1977. Commuter van programs: an assessment. Traffic Quarterly. 31(1): 33-57.

Discusses benefits to riders, drivers, employers.

Minnesota Energy Agency. 1975. How to organize a commuter van program: give your employees a commuting advantage. St. Paul: Minnesota Energy Agency.

Lists benefits and costs, advantages and disadvantages, to all involved. Step-by-step approach from survey to expansion.

Minnesota Highway Department. 1972. Carpooling demonstration. St. Paul: Minnesota Highway Department.

Use of vanpools by employees evaluated over a three year period.

_____ November 1974. Carpooling: a summary report, Twin Cities area. St. Paul: Minnesota Highway Department.

History of programs in Twin Cities area. Government sponsored program which failed in 1973 and why.

Minnesota State Planning Agency. December 1973. Methods and consequences of transportation fuel conservation. Preliminary Report No. 1. St. Paul: Minnesota State Planning Agency.

Study done by transportation section of Minnesota State Planning Agency to determine effect on fuel consumption of: 55 mph limit, four-day work week, and increased auto occupancy. Each studied alone and in combination.

Morin, Donald A. and Reagan, Curtis D. 1969. Reserved lanes for buses and carpools. Traffic Engineering. 39(10): 24-28.

Muehlke, Richard Vaughan. 1975. Government economic regulation of vanpooling. Unpublished plan B paper. Minneapolis: University of Minnesota, Department of Business Administration.

Provides figures on present level of low occupancy auto usage. Promotes various government support programs for pools. Lists each responding state's current regulations and viewpoints.

Murray, J. R. et. al. 1974 Evolution of public response to the energy crisis. Science. 184(4134): 257-63.

Nakib, Sam R. and Ligas, Joseph F. 1975. A park'n ride program for the Chicago area. Traffic Engineering. 45(3): 14-16.

Chicago's plans for future demand in terms of more computer parking lots.

Newman, Leonard. 1976. Bus-carpool FWY lane in San Francisco area. Transportation Engineering Journal. 102 (November): 625-35.

Time savings at four different locations resulting from a different carpool incentive at each location.

New York Times. December 9, 1971. Carpools use bridge free in coast experiment. p. 93.

_____May 18, 1970. San Francisco commuters shun carpool campaign. p. 58.

Owens, Robert D. and Sever, Helen L. May 1974. The 3M commute-a-van program status report. St. Paul: Minnesota Mining and Manufacturing Company Inc.

Discusses distribution of benefits.

Peat, Marwick, Mitchell and Co. July 1976. Survey tabulations and evaluation. Memorandum II of A marketing approach to carpool demand analysis. Washington D.C.: Peat, Marwick, Mitchell and Co. [PB261822]

_____July 1976. Tradeoff model and policy simulation. Memorandum III of A marketing approach to carpool demand analysis. Washington D.C.: Peat, Marwick, Mitchell and Co. [PB261823]

_____July 1976. Evaluation of model impact estimates. Memorandum IV of A marketing approach to carpool demand analysis. Washington D.C.: Peat, Marwick, Mitchell and Co. [PB261824]

Peskin, Robert. April 1975. The immediate impact of gasoline shortages on urban travel behavior. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration. [PB240866]

Petrocelli, Joseph. November 1974. The use of express buses and vanpools in Knoxville as alternatives to the driver-only automobile in the journey to work: a case study. Unpublished term paper for Dr. Wegmann. Knoxville: University of Tennessee.

Socioeconomic differences between traditional bus users and express bus users.

Pratsch, Lew W. 1974. Carpools: the underutilized resource. Civil Engineering 44(1): 49-52.

Pratsch, Lew W. January 1975. Carpool and buspool matching guide. 4th ed. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Brief description of: carpools, vanpools, buspools, combination of car/buspool, preferential treatment. Main concern is on the actual computer program for matching. Gives complete description of program used by FHWA.

_____1975. Carpools: how successful? Civil Engineering 45(2): 61-63.

Pratt, R. H. Assoc. Inc. 1973. Low cost urban transportation alternatives: a study of ways to increase the effectiveness of existing transportation facilities. Executive summary. Washington D.C.: U.S. Department of Transportation.

_____1973. Results of case studies and analysis of busway applications in the United States. Vol. II of Low cost urban transportation alternatives. Washington D.C.: U.S. Department of Transportation.

Pun, Chi Fai and Kidder, Alice E. May 1976. Factors influencing the success of company-based carpooling programs. Greensboro: North Carolina A & T State University, The Transportation Institute. [PB259434]

Importance of parts of program and employer attitudes. Trends. Potential for expansion.

Reed, Marshall F. Jr. 1975. The price of commuting. Traffic Engineering. 45(12): 41-42.

Robertson, H. D. 1974. Miami's bus-carpool project will move the greatest number of people, with least delay at lowest cost and with greatest convenience. Traffic Engineering. 44(4): 66-71.

Two lanes added in median of freeway to be reserved during two peak periods. Only a temporary solution.

Rosenbloom, Sandra and Shelton, Nancy T. September 1974. Carpool and bus matching program for the University of Texas at Austin, Council for Advanced Transportation Studies. Research Report 11. Austin: University of Texas.

Rothenberg, Morris J. and Wagner, Fred A. September 1975. Evaluation criteria related to bus and carpool traffic operational incentive projects: a working draft. Prepared for Federal Highway Administration by JHK & Assocs. and Alan M. Voorhees Assocs.

Categorizes variables needed in an evaluation of incentives.

Rubin, Richard B.; Bruggeman, Jeffrey M.; and Griffiths, Frank. January 1977. Adaptation and application of a quantitative marketing model to a carpool policy impact estimation. Paper presented to 56th Annual Meeting of the Transportation Research Board. Washington D.C.: Peat, Marwick, Mitchell & Co.

Survey type format compares travel time versus travel costs. Relates program policies to results.

Safavian, Reza and McLean, Keith G. 1975. Variable work hours: who benefits? Traffic Engineering. 45(3): 17-25.

The effects that variable work hours have in Ottawa on such things as mode split, transit ridership, auto traffic distribution, parking area, and vehicle occupancy.

Shallbetter, Clarence and Herzberg, Gary G. July 1975. Shared ride services. Minneapolis: Public Service Options.

Cost comparison of various commuting modes. Market determination of shared rides. Benefits to different groups.

Somerville, Richard, editor. 1976. Expanded transportation services. 1975 National Conference on Areawide Carpooling - Proceedings. Houston: City of Houston Car Share Program. [PB258844]

Brief discussion on incentives and programs using United Gas Pipeline Co., Florida DOT, California DOT, Seattle Carpool Program, Houston Car Share as examples.

Stokey, Stanley R.; Wegmann, Frederick J.; Chatterjee, Arun; and Mauldin, H. Don. 1977. An employer-based ride-share program in a medium-size urban area. Traffic Engineering. 47(1): 19-24.

Express bus use and successes discussed in depth. Vanpooling mentioned without detail. Other ride-share forms not discussed.

Svercl, Paul V. and Asin, Ruth H. August 1973. Nationwide personal transportation study: home-to-work trips and travel. Report No. 8. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Tischer, Mary Lynn and Dobson, Ricardo. January 1977. An empirical analysis of behavioral intentions to shift ways of traveling to work. Paper presented to the 56th Annual Meeting of the Transportation Research Board.

Model attempts to identify single-occupant auto drivers who may switch to carpooling. Relates behavior to perceptions of different system attributes.

Transportation Research Board. August 1975. Executive summary carpooling seminar. Transportation Research Circular. No. 169.

Upchurch, Jonathan E. 1975. Characteristics of reversible flow on a six lane urban arterial. Traffic Engineering. 45(12): 11-14.

Study done in Memphis to see if reversible lanes increase capacity; also what types of accidents it encourages.

Von Ehrenkrook, W. H. 1975. Arlington Park commuter station. Traffic Engineering. 45(1): 19-24.

Parking facilities were offered near train line into Chicago to cut down on autos into the city.

Voorhees and Associates. November 1973. A study of techniques to increase commuter vehicle occupancy on the Hollywood Freeway. Final Report. Sacramento: California Department of Transportation, Freeway Operation Branch.

Characteristics of poolers vs. non-poolers. Pooling techniques. Promotion of programs. Task force idea.

_____January 1974. Incentives to carpooling. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Discusses costs, travel time, convenience, intangibles, and organizational incentives.

_____January 1974. Legal and institutional issues of carpooling. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Legal, personal security, income/IRS, and insurance issues and problems.

_____January 1974. Organization for carpooling. Washington D.C.: U.S. Department of Transportation, Federal Highway Administration.

Current pooling efforts. Framework (responsibilities, makeup, programs) for local organization. How state can support local effort.

_____January 1974. Transportation pooling. Washington D.C.: Urban Mass Transportation Administration. [PB236157]

_____May 1974. Energy efficiencies of urban passenger transportation. Washington D.C.: Highway Users Federation.

Relative efficiencies of various transportation forms. Vanpool is best. Factors which alter efficiency. Expected reduction in fuel consumption given minor, major, or severe pool incentives.

Wachs, Martin. 1976. Consumer attitudes toward transit service: an interpretive review. AIP Journal. 42(1): 96-104.

Attitudes and the weighting of factors determining work trip mode choice. Possible ride-share incentives.

Wallace, Henry. February 1974. Metropolitan Toronto transportation planning review carpooling summary. Report # 35-A. Toronto: Ontario Ministry of Transportation, Toronto Transportation Commission.

Study to find short- and long-term alternatives in Toronto. Gives incentives and restrictions that could be used by public and private sectors and the effect of each. Parking stressed as incentive; also new zoning laws.

Yukubousky, Richard and Fichter, Donn. August 1974. Mobility club: a grass roots rural and small town transport concept. NYDOT Preliminary Research Report 69. Albany: New York Department of Transportation.

Carpool program operating on dial-in basis for low resident density areas. Club members pool when matched; no formal or permanent arrangements.

Zevin, Israel. April 1972. Carpooling in Connecticut. Hartford: Connecticut Department of Transportation. [PB213206]

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